Rapid Data Visualization

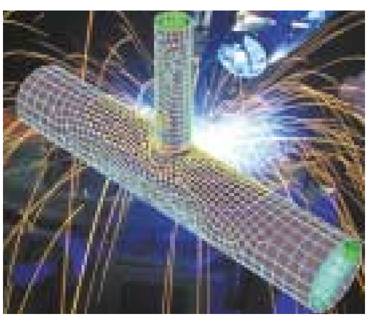
While most post-processing tools that have been available for the past decade have included volume rendering capabilities, they have typically been non-interactive tools in the engineering process due to hardware and algorithm limitations. With the advent of the modern graphics processing unit (GPU) and the new OpenGL2.0 standard, new tools and algorithms have been developed to allow volume rendering to take place in real-time.

One such tool is **Texture Based Engineering Tools (TBET)**, designed by Kenneth Bryden, Gerrick Bivins, and Douglas McCorkle, at Ames Laboratory, Iowa State Univ. TBET is a software toolkit that allows engineers to interrogate large transient datasets quickly by utilizing the GPU. It has initially been implemented with the Virtual Engineering Suite (VE-Suite) and is open source, available under the GNU Lesser General Public License.

TBET takes large 3-D data sets and quickly converts them into pictures that allow engineers to gain an unparalleled insight into problems represented by the data. It is a novel addition to the tools used within the engineering community, reducing the complexity that the engineering community has to deal with when working with complex models.

▶ More info: www.ameslab.gov

A Better Way to Analyze Stress



Engineers have struggled for decades to develop reliable stress calculation methods for fatigue design and life prediction routines of structures such as automobiles, aircraft, bridges, oil rigs, ship structures, and power plants. A key problem with conventional stress calculation methods is that they are mesh-sensitive at fatigue-prone locations such as notches and corners. Because existing methods depend so heavily upon computer model mesh or element size, the results from existing methods are not predictable. All of that has changed with the introduction of the **Verity** mesh-insensitive structural stress analysis method developed by researchers at Battelle, Columbus, Ohio. Verity's mesh-insensitive predictions eliminate the inconsistencies of current procedures and reduce the chance of design errors.

▶ More info: www.battelle.org

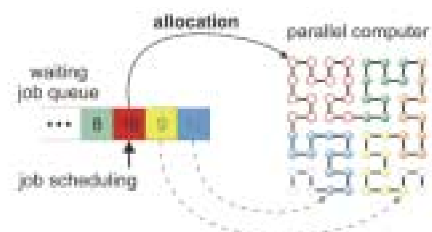
Building Smarter Robots

The allure of robots is that they can be sent into situations that are too dangerous or too difficult for humans. The problem with using robots for such demanding duty is that they lack the intrinsic intelligence necessary to be truly independent. Dependence on artificial input from positioning systems and/or direct human control produces a dangerous susceptibility to failure–when communications are lost, remote robots inevitably stop dead in their tracks or wander aimlessly. To combat this problem, David Bruemmer, Douglas Few, and Miles Walton, at Idaho National Laboratory, Idaho Falls, have developed the **INL Robot Intelligence Kernel (RIK)**, a low-cost, onboard control architecture that gives robots exceptional new levels of autonomy and "intelligence," revolutionizing robot capabilities and the robot/operator relationship.

The INL RIK provides any mobile robot with intelligence comparable to a highly trained police dog. Like a well-trained dog, robots enlisting the INL RIK are able to navigate complex indoor and outdoor spaces, search for objects and people, chase or follow suspects at high speed, identify target items such as landmines, and detect the movement of people or objects.

▶ More info: www.inl.gov

Optimizing Resource Allocation



Parallel processing on supercomputers gives rise to the problem of resource allocation. To address this issue, researchers at Sandia National Laboratories, Albuquerque, N.M., collaborated with researchers from the State Univ. of New York, Stony Brook, and the Univ. of Illinois, Urbana, to develop the **Compute Process Allocator (CPA)**. CPA is the first allocator to balance individual job allocation with future allocation over 10,000 processors, allowing jobs to be processed faster and more efficiently.

In simulations and experiments, CPA increased the locality and throughput on a parallel computer by 23% over simpler one-dimensional allocators. In simulations, CPA increased the locality on a parallel computer by 1% over more time-consuming, higher-dimensional allocators. CPA is distributed and scales to over 10,000 nodes, while non-distributed allocators have been scaled to only 4,096 nodes.

▶ More info: www.sandia.gov

Mining Sapphire

Scientists' ability to collect data far outpaces their ability to find useful information within it. This problem of data overload is an increasingly major impediment to progress in several scientific domains. To address this, researchers at Lawrence Livermore National Laboratory, Calif., used technologies from several different fields in developing **Sapphire Scientific Data Mining Software**, a toolkit for the analysis of massive, complex datasets arising from scientific experiments, observations, and computer simulations.

Sapphire focuses on the end-to-end process of finding useful information within data. Specifically, it provides capabilities for cleaning data, finding the objects of interest within the data, extracting characteristics representing the objects, identifying key characteristics, and then using these characteristics to find patterns in the data. Using a modular and extensible design for its software architecture, as well as support for a variety of algorithms for a task, it has been possible to use Sapphire for the analysis of problems in several different domains, such as astronomy, physics, remote sensing, and computer simulations of complex phenomena. It can also be applied to problems in national security and commercial applications such as credit card fraud detection and text mining.

▶ More info: www.llnl.gov

Visualizing the World's Population

High-resolution population distribution data are critical to successfully address important issues ranging from socio-environmental research to public health to homeland security. Commonly available census population data are severely constrained both in space and time and do not capture the population dynamics as functions of space and time. To that end, researchers at Oak Ridge National Laboratory, Tenn., have developed the **LandScan 2004 Global Population Database**. LandScan describes 24-hour average population distributions for every 30 arc second (approximately 1 km x 1 km) grid cell covering the world. This database is produced through an innovative, flexible, and dynamically adaptable spatial model that refines the best available census data utilizing remote-sensing-derived earth observation data and geographic information systems (GIS) technology.

At its current spatial resolution, LandScan has 25 times higher resolution than the next best global population database of its kind. As such, it has become the community standard for estimating population at risk. It has already made a significant global impact on our society through disaster response, humanitarian relief, sustainable development, and environmental protection.

▶ More info: www.ornl.gov

Revolutionizing Language Interoperability

Scientific computing applications typically combine software libraries written in multiple computer languages. For some pairs of languages, like C++ calling C, it is fairly easy to make cross-language function calls and pass data. For other pairs of languages, like C++ and Fortran 95, the approach for interoperability requires application developers to write platform- and compiler-specific "glue code" to translate arguments between languages. To reduce this manual burden, researchers at Lawrence Livermore National Laboratory, Calif., have developed **Babel**, software that makes function calls and passes scientific data seamlessly and efficiently from one computer language to another.

Babel is designed to deliver portable, high-performance language interoperability on the fastest massively parallel supercomputers. It manages and hides all of the programming complexities of making inter-language function calls between any combination of C, C++, Fortran 77/90/95, Java, and Python, behind a common interface.

Babel's architecture is also general enough to support newer languages. Any supported language can call any other supported language, and from the programmer's point of view, calling between languages is seamless.

▶ More info: www.llnl.gov

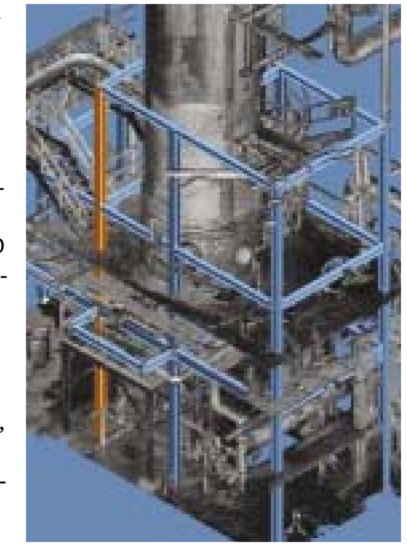
Making FPGAs More Accessible

Reconfigurable logic can accelerate applications, but only if it is usable by the scientists who are developing the applications. Creating designs for reconfigurable logic in hardware description language (HDL) can be difficult and time-consuming. Most application developers have little to no hardware design experience. However, high-level language compilers like **Trident**, developed by researchers at Los Alamos National Laboratory, N.M., ease this burden and allow more people to easily program field-programmable gate arrays (FPGAs).

Trident is an open source C compiler for reconfigurable supercomputers that accepts C language input containing floating-point calculations and translates this language into FPGA hardware. It allows computational scientists to explore partitioning their code between software and hardware. They can benefit by trying different optimizations and targeting different floating-point libraries.

▶ More info: www.lanl.gov

CAD Goes 3-D



The broad adoption of 3-D computer-aided design (3-D CAD) tools has resulted in dramatic improvements in design engineering productivity and the overall quality of new facility designs. There is, however, significant interest in using these same tools for modifications to existing facilities. Unfortunately, many existing facilities were designed and constructed prior to 3-D CAD and recreating the facility in 3-D CAD models would require many man-months of time-consuming and error-prone manual measurement. To address this issue, Fred Persi at Quantapoint, Inc., Pittsburgh, Pa., has developed **Quantapoint QuantaCAD**, a software technology that works with Quantapoint 3-D laser scanning to enable 3-D laser models to be accessed within 3-D CAD tools.

Quantapoint uses 3-D laser scanning to create dimensionally accurate, physically complete, and interactive 3-D models composed of laser data. With QuantaCAD, users can use 3-D CAD tools to extract the greatest value from the "digitized plant" to reduce risks throughout design.

▶ More info: www.quantapoint.com